DOCUMENT RESUME

ED 441 859 TM 030 895

AUTHOR Papanastasiou, Elena C.
TITLE Intelligence: Theories and Testing.
PUB DATE 1999-11-00
NOTE 28p.
PUB TYPE Information Analyses (070)
EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS *Environmental Influences; Genetics; Heredity; *Intelligence; Intelligence Tests; Nature Nurture Controversy; Performance Factors; *Test Use; *Theories

ABSTRACT

This paper reviews what is known about intelligence and the use of intelligence tests. Environmental and hereditary factors that affect performance on intelligence tests are reviewed, along with various theories that have been proposed about the basis of intelligence. Intelligence tests do not test intelligence per se but make inferences about a person's intelligence. Intelligence tests contain some measurement errors, and no single intelligence quotient (IQ) test or theory is uniformly accepted as the "best." It is suggested that the best way to test intelligence is to use a reliable battery of tests or combination of tests with many subcategories. These subcategories should reflect a wide range of abilities, processes, and contexts. In addition, the results of tests should be reported in a clear and analytical way. These reports should guide teachers and parents in helping each individual student in the most appropriate way. (Contains 3 figures, 3 tables, and 30 references.) (SLD)

Reproductions supplied by EDRS are the best that can be made
from the original document.

ED 441 859

Intelligence: Theories and Testing

Elena C. Papanastasiou

Michigan State University

November, 1999

TM030895

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

- This document has been reproduced as received from the person or organization originating it.
- Minor changes have been made to improve reproduction quality.
- Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

E. Papanastasiou

BEST COPY AVAILABLE

INTRODUCTION

Intelligence is a very controversial topic that has been debated greatly this last century. One of the main aspects of the original debate dealt with the nature or nurture controversy. Was intelligence an outcome of heredity or of the environment that individuals lived in? Numerous studies have examined this debate. Proponents of nature conducted correlational studies that showed that there were significant correlations between IQs within families. On the other hand, proponents of nurture conducted studies that showed that by changing people's environments, their intelligence scores were changing as well. Nowadays, it has been accepted that both, nature and nurture influence a person's intelligence. What is still not clear however, is how much variation in intelligence is accounted for by nature, how modifiable intelligence is, as well as under what circumstances intelligence can be modified (Angoff, 1988).

Another issue about intelligence that is still not clear is the issue of what the nature of intelligence is. Numerous structures and theories of intelligence have been proposed, many of which have aspects that overlap with each other. No conclusion has been reached however, about 'the best' or most realistic representation of the construct of intelligence. Another problem with intelligence testing, is the fact that "psychologists cannot define intelligence, or at least cannot agree on a definition, and therefore cannot possibly measure it" (Jensen, 1980, p.7). Therefore, due to all these uncertainties, some critics argue that there is no reason for using IQ tests since we cannot really define or measure this construct. However, according to Ebel (1979),

> "if we cannot solve the mystery of intelligence, why waste time thinking and writing about it?
> - Because we do know something. Our uncertainty is not due to total ignorance.
> - Because we do care about it very much. It is a precious part of our humanity.

- Because we do talk about it, though not always wisely or on the basis of good information, and sometimes with much more assurance than is warranted.
- Because, in the areas of our uncertainty some hypotheses are more credible than others, and more beneficial in their social consequences.
- Because the more we find out about it and the more precisely we think about it, the more wisely we are likely to behave in matters involving educational or personal decisions.

To be skeptical of some statements made about intelligence is not to dismiss the subject as trivial or unworthy of study" (p.14).

THEORIES AND METAPHORS OF INTELLIGENCE

In trying to define the construct of intelligence, many theories have been proposed concerning this topic. Sternberg (1990) organized the theories based on seven metaphors of intelligence that will be discussed below. These metaphors were also categorized along two additional dimensions; the theories of intelligence that look inward and the theories of intelligence that look outward. However, even though this is a good attempt to summarize the various types of intelligence theories, I believe that the metaphors cannot be clearly divided along two dimensions that are mutually exclusive. This is especially true since many theories believe that there is an interaction between nature (that looks inwards) and nurture (that looks outwards). In addition, Sternberg's categorization of theories also comes in contrast to the fact that has been widely accepted today, that intelligence is influenced by both, nature and nurture. For clarity and organizational purposes however, the following review of theories of intelligence will be based on Sternberg's (1990) classification of theories of intelligence.

I. Theories of intelligence looking inward

A. Geographic metaphor

"The geographic metaphor is based on the notion that a theory of intelligence should provide a map of the mind" (Sternberg, 1990, p.6). The theories that belong to

this metaphor all focus on the structure of intelligence. Therefore, they base their theories and assumptions on the results obtained from performing factor analyses with data from various intelligence tests.

Spearman (1927) can be considered as a representative of this metaphor. In 1927 he proposed a two-factor theory of intelligence, whose basic assumption was that every ability, including intelligence, can be separated into two factors- a universal or general factor, called the 'g' factor, and other specific factors, 's'. This theory was developed after Spearman noticed certain positive correlations among batteries of intelligence tests. Specifically, he noticed that the following equation formula, called the *tetrad equation* held true in most situations.

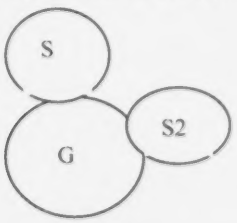
$(r_{as} \times r_{bq}) - (r_{aq} \times r_{bp}) = 0.$ Equation 1

Therefore, he assumed that there was a common element of 'general intelligence' that was included in all intelligence tests. This factor, which was also the first principal component of a factor analysis, was named the 'g' or 'general' factor. This g-factor was also explained by Spearman as a person's intelligence, mental energy, concentration, or will power (Spearman & Jones, 1951).

Spearman, however, also noticed that the g factor did not account for all of the variance in the correlation matrix of intelligence tests. This occurred whenever the tetrad equation difference (also called the determinant) did not equal zero. The tetrad equation difference was then explained as the specific 's' factor of intelligence. The specific factor, 's', contains many types of specific mental abilities that are uncorrelated with each other (Spearman, 1927).

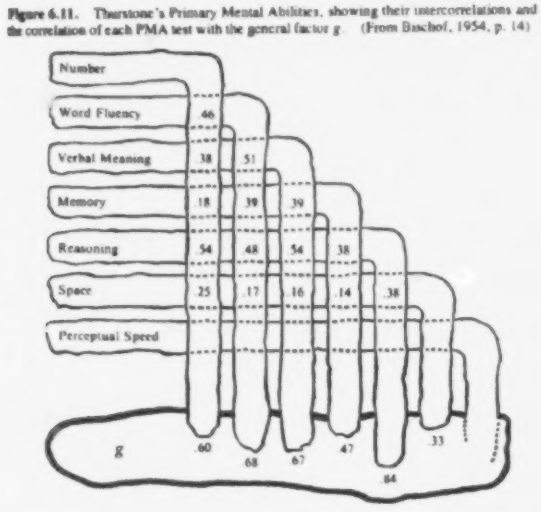
Figure1 shows a visual representation of Spearman's theory of intelligence.

Figure1. Spearman's theory of intelligence



Thurstone (1938) is another major representative of the geographic metaphor. Based on his factor analysis (with rotated axes) of 56 psychological tests, he came up with seven factors that accounted for his theory of primary mental ability. The seven factors were the verbal-comprehension factor (V), the word fluency factor (W), spatial visualization (S) , number (N), the memory factor (M) , inductive reasoning (I or R) , and the perceptual-speed factor (P) .The deductive factor (D), has also been proposed in some studies. However, it is mostly considered as a tentative factor since it has not always appeared in repeated studies of intelligence (Thurstone & Thurstone, 1941). A visual representation of Thurston's theory of intelligence is presented in Figure2.

Figure 2. Thurstone's theory of intelligence



(Jensen, 1980, p.215)

Guilford (1967), was a researcher that proposed the 'structure of intellect' (SI) model that consisted of 120 abilities (that were later on increased to 150), that were

categorized along the three dimensions of operations, products, and contents. The operational dimension had five subcategories; the products dimension had six subcategories, while contents had four. Each dimension interacted with each other in order to finally create 5 x 6 x 4 = 120 categories of abilities. A major disadvantage of this theory, however, is that since it has many subcategories, and therefore, many subtests, these subtests tend to be shorter, and thus less reliable. Guilford's structure-of-intelligence model is depicted in Figure 3 (Guilford, 1967, p.63).

Figure 3. Guilford's structure of intelligence model

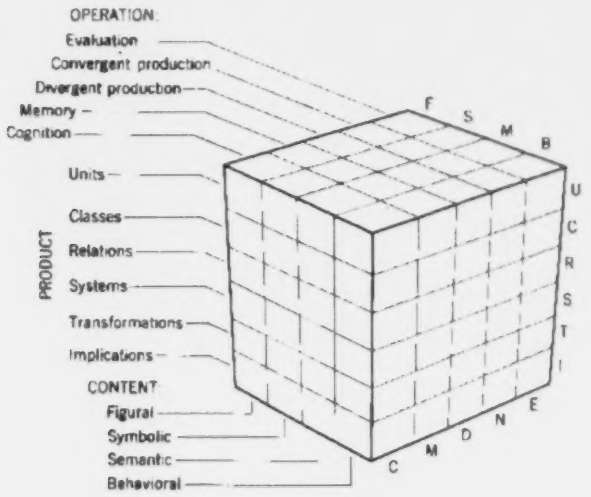


Fig. 3.9 The structure-of-intellect model, with three parameters (other parameters may need to be added).

Hierarchical theories of intelligence have also been used very frequently. Cattell (1971) is a major representative of this type of theories. Cattell proposed the existence of crystallized and fluid abilities. Crystallized abilities consist of knowledge accumulated throughout the life course. Fluid abilities are those that include abstract thinking and flexibility of thought.

BEST COPY AVAILABLE

Based on Sternberg (1990), one of the reasons why the geographical metaphor of intelligence has become less popular, is because it only takes into account the *structure* of intelligence, and not the mental processes of individuals. Therefore, based on these models, individuals with different mental processes might obtain the same IQ scores, even though they have answered different sets of questions correctly. Another disadvantage of the geographic theories, according to Sternberg (1990), is that it is difficult to compare such factor analytic models to each other due to rotational issues, since there is no single correct way of rotating the axes. Various researchers use different types of factor analysis rotations, which result in obtaining different results that are not necessarily comparable with each other.

B. The computational metaphor

The main idea behind the computational metaphor deals with examining the processes that underlie the various factors of intelligence that are proposed by the geographic metaphor (Sternberg, 1990). One advantage of this metaphor, is that it complements the geographical metaphor which only examins the structure, and not the process of intelligence. Another advantage of this metaphor is that it was also a means of getting away from the many subcategories of intelligence that were proposed based on the geographical metaphors. However, researchers soon realized that processes could also be divided in numerous subcategories, so it did not solve the problem of the many subcategories. A final comment on this metaphor, according to (Sternberg, 1990), is that "it has become clear that there is no real way of knowing whether it is the processes that underlie the factors or the factors that underlie the processes" (p.9).

C. The biological metaphor of intelligence

"Biological based theories seek to understand intelligence in terms of the functioning of the brain" (Sternberg, 1990, p.10). These theories are based on two types of studies. The first category of studies try to examine the types of functions that are lost after the destruction of portions of the brain. The generalizations of the results from such studies however, are questionable since the subjects of these studies are not representative of the whole population. The second category of studies used in the biological metaphor, deal with electrophysiological data. This type of data is obtained by taping electrodes to a person's scull and measuring potentials while individuals are performing various tasks (Sternberg, 1990). Such studies are rarely used today in educational settings, though.

D. The epistemological metaphor

Jean Piaget can be considered as the main representative of the epistemological approach. According to Piaget, "intelligence, the most plastic and at the same time the most durable structural equilibrium of behavior, is essentially a system of living and acting operations. It is the most highly developed form of mental adaptation, that is to say, the indispensable instrument for interaction between the subject and the universe " (Piaget, 1947, p.7). In order to obtain this equilibrium, people adapt by assimilating to the changes in their environment, while at the same time the environment accommodates to the changes of living organisms. Piaget (1970) also had another part of his theory of intelligence, which dealt with the developmental stages of children (maturation, experience, physical environment, and equilibration, which is a child's self-regulatory process).

II. Theories of intelligence looking outward

E. The anthropological metaphor

The anthropological metaphor views intelligence as a cultural invention, that is not universal, but varies from culture to culture (Sternberg, 1990). Therefore, intelligence according to this view, is based more on the external rather than the internal world of each individual. Therefore, it assumes that intelligence has more to do with the environment of each individual rather than something inside the mind or the body. A proof for this is the fact that IQ tests cannot be directly transferred from one culture to another due to culture biased items on the test.

The disadvantage of this metaphor, however, is its extremity, since it does not take into account the genetic buildup of each individual. Another disadvantage of this theory, based on Sternberg (1990), is that the construct of 'context', on which the whole theory is based, is not defined, which makes the theory rather vague.

F. The sociological metaphor

Lev Vygotsky can be considered as the main representative of the sociological approach. His views are that while growing up, children internalize the social processes they observe in their environments, and internalize them inwards (Sternberg, 1990). More specifically, this metaphor focuses on how "socialization processes affect the development of intelligence"(Sternberg, 1990, p.17). However, this is not a complete theory of intelligence yet, so its usefulness cannot be critiqued properly.

G. The systems metaphor

The systems metaphor of intelligence contains some of the newest theories of intelligence that combine and interact systems of intelligence or multiple intelligences

(Sternberg, 1990). These theories are quite complex since they attempt to combine aspects of many other metaphors in order to create new comprehensive theories.

Based on Howard Gardner's (1995) theory of multiple intelligences (MI), there are seven main intelligences; linguistics, logical-mathematical, spatial, musical, bodily-kinesthetic, interpersonal, and intrapersonal. However, even though these intelligences are distinct, they are also independent, in that a person's ability on one type of intelligence cannot predict the same person's ability on any other type of intelligence. In addition, based on Gardner, these seven principles interact with each other. However, a major disadvantage of Gardner's theory, is that it lacks empirical evidence (Lubinski & Benbow, 1995). Despite this fact, though, educators do tend to use this metaphor widely (Gardner, 1995).

WHAT THINGS *DO* WE KNOW ABOUT INTELLIGENCE?

Even though various theories have been proposed about intelligence, many of which have aspects that overlap with each other, no consensus has ever been reached about a universal definition of the concept of intelligence. However, the numerous studies that have taken place concerning this topic have provided us with some indisputable information concerning this construct.

I. Heredity effect

A consistent, but not surprising research finding shows that children's IQs are significantly correlated with their parent's IQs (Blau, 1981; Lehrke, 1997). According to Waldman (1997), heridability estimates (h^2), range from 0.4 to 0.8 which mean that approximately 40-80% of intelligence variance is due to genetic differences. Brody

(1999) also discussed how maternal IQ levels accounted for 3-4 times more variance than any intensive environmental intervention effect for 12-year old children. This should not be surprising. According to Ebel (1979), "there must, of course, be some physical basis for intelligence.... And since individual human beings differ considerably in their physical characteristics, in size and shape and color and comeliness, it is reasonable to suppose that they must differ also in their physical bases for intelligence. But no one has discovered why physical differences among normal human beings affect their intelligence, or how much they affect it " (p.16).

Studies have also shown that this correlation varies based on the gender of the parent and the child. Lehrke (1997) for example, discussed that the correlations between sons with their fathers are the lowest (r=.44), while the correlations between mothers and daughters' IQs are the highest, at about r=.68.

II. Environmental effects

There is no doubt that intelligence is influenced by the environment that individuals live in (Brody, 1999). Waldman (1997) discusses how 10-40% of individual differences are accounted for by cognitive ability experiences that are shared within families. Another 10-30% of individual differences are accounted for by unique experiences that are not shared between members of the same family. It should be noted though, that the magnitude of the shared environmental influences depend on the type of relationships between family members, as well as on the age of each family member. These percentages should be considered with caution, though, since about 9-15% of the total environmental variance might be due to measurement error.

Another example of the effect of environmental factors on intelligence, is discussed by Jensen (1972) who has shown that children who came from extremely deprived environments could boost their IQs from 20, 30, or as much as 70 points after

being relocated to average environmental circumstances. However, this situation does not hold true for children that are relocated from average to above average and enriching intellectual environments (Jensen, 1972a).

Intelligence and education

Schooling can also be considered as an environmental factor that can effect intelligence (Brody, 1999). Ceci and Williams (1997) have provided seven types of evidence to show that schooling has an effect on IQ. The first type of evidence shows that the effect of intermittent school attendance has negative consequences on children's IQs. In a study conducted by Freeman (1934) as cited in (Ceci & Williams, 1997), it was shown that the children of gypsies or canal-boat parents that did not attend school regularly, had subnormal levels of intelligence even though the same children had about average IQ scores at the age of 5. This shows that the children tend to be intellectually normal in their first 5 years of life, since intelligence at that age does not depend as much on school experiences. This is not the case later on in life, though.

The second type of evidence is based on the effects of delayed school start-up. In studies conducted by Ramphal in South Africa, and of DeGroot in the Netherlands, as cited in Ceci and Williams (1997), it was shown that IQ scores tend to decrease for every year of delayed schooling that the children experienced. Other types of evidence showed that remaining in school longer, and starting school at an earlier age, also had a positive influence on children's IQs. Finally, the effect of discontinued schooling, along with the effects of summer vacations had negative effects on students' IQ scores (Ceci, 1991; Ceci & Williams, 1997).

III. Interaction of heredity vs environment

Despite the accepted fact that heredity and environment both affect a person's intelligence, it is not always clear to what extent they have a main effect on intelligence, or how much they interact with each other in terms of IQ and schooling.

> "It is easy to fall into the trap of interpreting the correlational data as supporting one's causal hypothesis, when in fact one knows that correlations do not permit causal inferences. IQ differences between groups may lead to differences in societal outcomes; differences in societal outcomes may lead to IQ differences; both may be dependent on some third factor. Or any combination of these three mechanisms may be at work" (Sternberg, 1996, p.15).

In discussing why parent's IQ's are related to their children's achievement, Brody (1997) has offered the following explanation: "Parents with high IQs may press greater emphasis on academic achievement than parents with low IQ. The former parents may be more successful at providing intellectual stimulation to their children and at arranging appropriate educational experiences for them. Therefore, in natural families, the influence of environmental and genetic influences are confounded, and genetically informed designs are required to study genetic and environmental influences of parents on children (p.1048)".

It is also possible that the influence of schooling and genetics are also confounded with each other. First of all, children of parents with high IQ might be provided with more educational opportunities than children of parents with lower IQ scores (Brody, 1997; Brody, 1999). However, it is not always clear if high levels of schooling, and the educational opportunities that are provided in schools are a cause of increasing IQ scores, or if people with high IQ scores tend to stay in school longer (Brody, 1999; Ceci & Williams, 1997; Suzuki & Valencia, 1997).

IV. Group differences

As a result of the interaction of environmental and hereditary effects on intelligence, group differences in IQ scores tend to appear.

Racial differences

"Whatever the origins of the current differences between Blacks and Whites on psychometric tests, it is clear that much more is going on in terms of differences in societal outcomes than is caused by IQ differences themselves" (Sternberg, 1996, p.15). Suzuki and Valencia (1997) have stated that educational opportunity is an important correlate to consider in terms of intelligence, given that particular minority racial-ethnic groups have varying levels of school achievement as well as disproportionately higher dropout rates. This is in accord with Blau (1981) who has shown that the strongest predictors of IQ for children were the following: race, mother's social milieu (which included the proportion of close neighbors that go to college, the mean education of the mother's closest friends), as well as father's education. These variables accounted for 23% of the total variance of IQ scores.

Gender differences

Differences are also known to vary between genders. Halpern (1997) has correctly noted that the size of sex differences cannot be summarized in a single number since the differences depended on various factors such as the age of the individuals, as well as on the types and context of abilities that are tested.

According to Lehrke, (1997) there tends to be a larger proportion of males than females in the higher ends of the IQ scale. However, this is only because males tend to be more variable in their IQs than females. It has also been shown that females tend to do better in language usage areas of tests, while males tend to perform better on subjects such as mathematics, computers, and physics (Stanley, 1997).

In the book 'Bias in Mental Testing" Jensen, (1980) had compiled a table of studies of sex differences in relation to tests that were published since 1966. The majority of the studies found no significant gender differences. In the studies that did show such differences, however, the tests of general intelligence, verbal ability, and divergent verbal thinking favored females. In addition, the tests of quantitative ability, visual-spatial ability, and reasoning favored males. Overall, though, these differences seemed to balance each other out.

IQ and social status

Group differences also tend to appear in terms of social status. White (1994), as cited in Brody (1997), has shown in a meta-analysis of studies that the correlation between IQ and indices of social status is .33. In another study conducted by Ceci and Williams (1997), it was shown that high IQ scores, as well as high levels of schooling were positively and significantly related to levels of income. According to Brody (1999), there is no doubt that "the amount of education completed by a person is an important influence on the occupational status of an adult. The influence of intelligence on education and occupational status may even be observed in comparison of brothers reared in the same family. The brother with higher IQ in early adolescence is likely to obtain more education and to have a higher occupational status" (p.9). However, IQ levels have a smaller effect on income than non-IQ factors (Ceci & Williams, 1997).

Hernstein and Murray (1994) as cited in Sternberg (1996), have also shown that people in the highest prestige occupations in the USA tend to have higher IQ levels. This is not surprising to Sternberg (1996), who explains that in order to enter such high prestige occupations, candidates need to pass through multiple cognitive tests (such as the SAT, GRE, LSAT, MCAT, GMAT) that tend to weed out the candidates with lower IQs. Wilk, Desmarais, and Sacket (1995) as cited in Brody (1997) have shown that

"individuals gravitate to jobs that are congruent with their initial IQ level" (p. 1047). This shows that "the educational system and occupational hierarchy act as an intellectual 'screening' process, far from perfect, to be sure, but discriminating enough to create correlations of the magnitude just reported" (Jensen, 1972a, p.153).

IQ TESTS AND IQ TESTING

I. Problems associated with IQ testing

There have been numerous criticisms of mental testing throughout the literature. Most of the criticisms, however, are associated with the improper uses and interpretations of intelligence test scores rather than with the test itself. Some of the main criticisms found in the literature, as stated by Gardner (1982) are the following: "1. Improper or inappropriate reporting on the test results to the public, 2. failure to report to parents in a meaningful fashion, ... 4. Coaching or teaching for the test, 5. Using test scores in isolation for decision making ..."(p.323).

Many of the misuses of the tests, however, can be eliminated if the following information suggested by Gardner (1982) is taken into account;

a) Carefully read the test manuals in order to select the appropriate test for the appropriate student population
b) Recognize that there is an error of measurement associated with each test score, so the test scores themselves should not be considered in absolute terms as the true intellectual ability of a person
c) Use multiple test scores for decision making. People should not try to generalize the scores of a single test to various other subjects and situations. In addition, they should also include information from various sources (e.g. extracurricular activities, SES, and motivation) for a proper decision making process.

d) Properly interpret the reported test scores. Scores such as grade equivalents are often difficult to interpret properly. Therefore, both teachers and parents should be assisted in interpreting the various test scores appropriately.

However, there are other more difficult problems associated with intelligence testing that need to be taken into account. One of these problems is that of bias. According to Gardner (1982) "a test is biased for members of a subgroup of the population, if in the prediction for which the test was designed, the predicted score is consistently too high or too low for members of that subgroup. The second involves bias in the test itself, in the sense that the score does not represent a measure of the 'true' ability being tested"(p.328). Test constructors have tried to create culture fair tests in order to deal with this problem, where cultural factors are equally balanced across all cultures that will use such tests. However, Ebel (1979) believes that culture-free, just like culture-fair tests are equally as elusive.

Another problem with IQ tests is that it is very difficult to measure how constant IQ scores are for individuals. According to Ebel, "Constancy of the IQ has been difficult to demonstrate. Part of the problem may be in the tests. There is no substantial consensus on a single operational definition of intelligence. Different tests give somewhat different IQ 's. Different tests are required at different ages, and equating IQs across ages (and across tests) is troublesome" (Ebel, 1979, p.17). Therefore, it is advisable if comparisons of IQ scores between ages or grades are avoided due to the unreliability of such comparisons.

II. Correlations between IQ tests

Jensen (1980), as shown in Table 1, had summarized numerous studies that examined the correlations between various types of standard intelligence tests.

According to Jensen, the overall mean of the correlations was .67. However, the correlations ranged from 0.04 to 0.94! Part of the problem is because different tests were standardized on different populations, or because different tests have non-equal interval scales (Jensen, 1980). This is a big problem for IQ testing, since this means that a person's measure of intelligence can vary greatly based on the tests they take. For this reason it is strongly suggested that multiple sources of information are combined with IQ scores in order to make the most appropriate educational decision.

Table 1. Correlations between IQ tests

Table 8.5. Correlations between various standard intelligence tests reported in the literature. (Data from Buros, 1972, Vol. 1; Matarazzo, 1972, pp. 245–246; Sattler, 1974, pp. 125, 155, 236–246, Appendix B)

Tests	Correlations[1]
Wechsler-Bellevue I ×	
Stanford-Binet (1937)	.62, .86, .89
Raven Progressive Matrices	.55
Army Alpha	.74
Army General Classification Test	.83
Kent EGY	.65, .69
Shipley-Hartford	.72, .76
Thorndike CAVD	.69
Otis	.73
Wechsler Adult Intelligence Scale ×	
Stanford-Binet	.40–.83 (.77)
Raven Progressive Matrices	.53, .72, .83
SRA Nonverbal	.81
Army General Classification Test	.74
Army Beta (Revised)	.37, .82, .83
Ammons Picture Vocabulary	.76–.84 (.83)
Peabody Picture Vocabulary	.86
Kent EGY	.70, .77
Shipley-Hartford	.73–.86 (.77)
Otis	.78
Thurstone Test of Mental Alertness	.62
Wechsler Intelligence Scale for Children ×	
Stanford-Binet (47 studies)	.43–.94 (.80)
Columbia Mental Maturity Scale	.50–.76 (.64)
Draw-a-Man	.04–.59 (.36)
Raven Progressive Matrices	.27–.91 (.15)
Quick Test	.35–.84 (.41)
Peabody Picture Vocabulary Test	.30–.84 (.63)
Pictorial Test of Intelligence	.65, .71, .75
Slosson Intelligence Test	.50–.84 (.67)
Hiskey-Nebraska Test of Learning Aptitude	.82
Stanford-Binet ×	
Peabody Picture Vocabulary (37 studies)	.22–.92 (.66)
Pictorial Test of Intelligence	.38–.78 (.69)
Columbia Mental Maturity Scale	.39–.87 (.71)
Slosson Intelligence Test	60–.94 (.90)
Cooperative Preschool Inventory	.39–.65
Hiskey-Nebraska Test of Learning Aptitude	.78–.86
Kahn Intelligence Test	.62, .75, .83
California Test of Mental Maturity	66–.74
Peabody Picture Vocabulary Test ×	
Pictorial Test of Intelligence	77
Columbia Mental Maturity Scale	.53
A Variety of (24) Other Ability Tests (not including WISC and S-B)	.06–.90 (.53)
Pictorial Test of Intelligence ×	
Columbia Mental Maturity Scale	53
Leiter International Performance ×	
S-B and WISC (8 studies)	.56–.92 (.83)

314

(Jensen, 1980, p. 314).

BEST COPY AVAILABLE

III. Interpreting IQ scores

It is known that the average population mean has an IQ of about 100, with a standard deviation (sd) of 15. Based on the Wechsler Adult Intelligence Scale, Table 2 shows the conventional intelligence classifications in seven major categories. One should keep in mind, however, that such classifications are quite arbitrary. However, these are included in this paper to provide a rough estimate of the distributions of such classification.

Table 2. Distribution of IQ classifications

Classification	Interval in P.E. (probable error) Units	IQ Interval	% included
Retarded	-3 PE and below	69 and below	2.2%
Borderline	-2 to -3 PE	70-79	6.7
Dull-normal	-1 to -2 PE	80-89	16.1
Average	-1 to +1 PE	90-109	50
Bright-normal	+1 to +2 PE	110-119	16.1
Superior	+2 to +3 PE	120-129	6.7
Very superior	+3 PE and above	130 and above	2.2

(Jensen, 1980) p.108.

Jensen (1980) has also provided a table that was compiled by Cronbach (1960) of the typical IQ levels for various criteria. Again, even though this table is not very detailed or complete, it does give a rough description of people's abilities at various IQ levels.

Table 3. Capabilities at various IQ levels

IQ	Criteria
130	Mean of persons receiving Ph.D.
120	Mean of college graduates
110	Mean of high school graduates. Has 50:50 chance of graduating from college
100	Average of total population
90	Mean of children from low-income city homes or rural homes. Adult can perform jobs requiring some judgement (operate sewing machine, assemble parts)
60	Adult can repair furniture, harvest vegetables, assist electrician
40	Adult can mow lawns, do simple laundry

IV. Mismatch between intelligent performance and IQ

Numerous studies have shown examples of people that do not necessarily show high performance on traditional IQ tests, but perform certain tasks in very intelligent manners (Sternberg, Wagner, M., & Horvath Joseph, 1995; Sternberg, 1996). For example, Ceci (1990) reported the examples of expert racetrack handicappers who were able to use complex multiplicative models with multiple interaction effects (e.g. seven way interaction models) to predict the odds of each horse. Despite their complex thinking, however, there was no relation between the experts' IQs with the complexity of their thinking.

Another study by Carraher, Carraher, and Schliemann, has shown that Brazilian street children were frequently able to solve concrete and applied math problems applied to their daily lives, even though they were unable to solve similar problems with no context (Carraher, Carraher, & Schliemann, 1985). Specifically, 98.2% of the

problems that were presented in a familiar context were correctly answered by the children, in contrast to 36.8% of the questions answered correctly about math operations with no context.

On the other hand there are also many cases of individuals that are brilliant in their specific academic research fields, and yet are incompetent in other environments such as in their social interactions or in teaching (Sternberg et al., 1995) such as Norbert Wiener, as cited in (Stanley, 1997). This shows that people that do not perform well on intelligence tests should not be considered as not intelligent since IQ scores do not capture all aspects of human intelligence.

CONNECTIONS TO EDUCATION-

HOW CAN WE USE INTELLIGENCE FOR OUR BENEFIT?

The way that intelligence is perceived by teachers can have very important consequences for teaching. If a teacher believes that the differences between individuals are stable and are only due to hereditary reasons, that teacher might spend little trying to reteach information that has not been understood by individuals with limited intelligence (Ebel, 1979).

> "Teachers who see intelligence as an inherent characteristic that limits the learning of some pupils have tended to use IQ scores more to explain why some pupils do not learn than to help all pupils to learn more. They have tended to see intelligence as a characteristic in which races differ, as they differ in other inherited characteristics. Instead of using intelligence test scores to insure equality of educational opportunity, they have used them to deny it. This is one reason why some schools and school systems have dropped intelligence tests from their testing programs" (Ebel, 1979, p.20).

Therefore, the purpose of such testing should not be to determine a student's inherited abilities. Nor should teachers base any of their instructional decisions solely on intelligence scores. "Differences in learning achievement ...should be attributed with more obvious validity to differences in prior achievement and success in learning; to

favorable or unfavorable early environments for cognitive development; to differences in motivation towards efforts to learn. The task is to help *all* pupils to learn" (Ebel, 1979, p.20).

From my point of view, this also has consequences on the ways in which intelligence scores should be reported. I believe that it is more important to report a breakdown of the students' scores on IQ tests since that would better reflect the students' abilities rather than a single combined IQ score. These consequences are reflected well in the following example reported by Stanley (1997); "A child with an IQ of 150 may have verbal ability corresponding to 130, and mathematical ability corresponding to 170, which average 150. In regular classes, the demands of the subject may be so slight that the high-IQ student appears to be equally able in English and Mathematics, A+ in each. Put the same child into a fast-paced, high level math class, however, where other 150 -IQers have math aptitude at level 170, and he or she probably won't be able to keep up. In such a special *English* class, the student could do well without great effort" (Stanley, 1997, p.97).

In addition, to providing an analytical breakdown of IQ subtests, I believe that educators should also use multiple data sources for making any types of educational decisions. This is due to a) the unreliability of some IQ tests, b) the fact that not all IQ tests correlate highly with each other, and c) the fact that IQ tests do not capture all aspects of human intelligence.

Finally, in addition to teachers, the public should also be trained on how to interpret intelligence scores properly. That should include an understanding of what each test is trying to measure, as well as what a particular score obtained from a specific intelligence test means. This would eliminate many of the societal problems associated with IQ scores such as stigmatizing, labeling or even comparing students based on such scores. "Ultimately the problem is not with tests, per se, but with how we use them.

Tests were originally intended to level the playing field-to increase fairness by reducing the subjectivity of judgements about children. Tests can still serve this purpose, when they are used in conjunction with other predictors and when they measure diverse abilities rather than only unitary aspects of ability" (Sternberg, 1996, p.14).

CONCLUSION

This paper has discussed that a) both, environmental and heredity factors can affect performance on intelligence tests, and b) environmental and hereditary factors interact with each other in determining a person's overall intelligence. It is also known that a) intelligence tests do not test intelligence per se, but make inferences about a person's intelligence, b) intelligence tests include some measurement errors, c) intelligence can be subdivided in numerous subcategories based on the various theories of intelligence, d) there are many intelligence tests, and e) there is no single IQ test or theory that is uniformly accepted as the 'best' test or theory. All the points mentioned above reflect the fact that there are no absolute answers or solutions that are related to intelligence. Consequently, I believe that the best way to test intelligence, is by choosing a reliable battery of tests, or combinations of tests that include many subcategories. These subcategories should reflect a wide range of abilities, processes, and contexts. In addition, the results of the tests should be reported in a clear and analytical way (based on abilities, processes, and contexts), so that they can provide a clear description of what individuals know, do not know, can and cannot do.

All of this information should be helpful so that teachers, as well as parents can help each individual student in the most efficient and appropriate way. This suggestion, of course, takes into account the assumption that environmental factors can influence a person's abilities and intelligence.

SUGGESTIONS FOR FURTHER STUDY

Studies have shown that the various intelligence tests do not correlate perfectly with each other. The various IQ tests are not equated, and are not interchangeable either. Therefore, it is possible that a person's IQ score could vary considerably from test to test. I believe that it would be interesting to try to create transformations in the scores between the various types of tests. Therefore, by administrating only one specific IQ test, we would try to estimate the score that an individual could have obtained if they had taken any other IQ test. This estimation could be useful for the purpose of obtaining a more precise, unitary, and universal definition of what intelligence scores measure.

BIBLIOGRAPHY

Angoff, W., H. (1988). The nature-nurture debate, aptitudes, and group differences. American psychologist, 43(9), 713-720.

Blau, Z. S. (1981). Black children/ white children. Competence, socialization, and social structure. New York: The Free Press.

Brody, N. (1997). Intelligence, schooling, and society. American Psychologist, 52(10), 1046-1050.

Brody, N. (1999). What is intelligence? INternational review of psychiatry, 11(1), 19-25.

Carraher, T. N., Carraher, D. W., & Schliemann, A. D. (1985). Mathematics in teh streets and in schools. The British psychological society, 3, 21-29.

Cattell, R. B. (1971). Abilities, their structurem growth, and action. Boston: Houghton Mifflin Company.

Ceci, S., J. (1990). On intelligence more or less. a bio-ecological treatise on intellectual development. Englewood Cliffs, NJ: Prentice Hall.

Ceci, S. J. (1991). How much does schooling influence general intelligence and its cognitive components? A reassessment of the evidence. Developmental psychology, 27(5), 703-722.

Ceci, S. J., & Williams, W. M. (1997). Schooling, intelligence and income. American Psychologist, 52(10), 1051-1058.

Ebel, R. L. (1979). Intelligence: A skeptical view. Journal of development in education, 12(2), 14-21.

Gardner, E. (1982). Some aspects of teh use and misuse of standardized aptitude and achievement tests. In A. K. Wigdor & W. R. Garner (Eds.), Ability testing. Uses, consequences, and controversies. (Vol. II, pp. 315-332). Washington DC: National academy press.

Gardner, H. (1995). Reflctions on multiple intelligence. Myths and messages. Phi Delta Kappan, 77(November), 200-209.

Guilford, J. P. (1967). The nature of intelligence. New York: McGraww-Hill Book Company.

Halpern, D., F. (1997). Sex differences in intelligence. American Psychologist, 52(10), 1091-1102.

Jensen, A., R. (1980). Bias in mental testing. New York: The free press.

Jensen, A. R. (1972b). Genetics and education. Edinburgh, Great Britain: T. & A. Constable.

Jensen, A. R. (1972a). Genetics and education. London: Methuen & Co. ltd.

Lehrke, R. (1997). Sex linkage of intelligence. The X-factor. London: Praeger.

Lubinski, D., & Benbow, C. P. (1995). An opportunity for empiricism. Contemporary psychology, 40(10), 935-940.

Piaget, J. (1947). The psychology of intelligence. New York: harcourt, Brace, & Company, Inc.

Spearman, C. (1927). The abilities of man. Their nature and measurement. New York: The Macmillan Company.

Spearman, C., & Jones, L. I., Wynn. (1951). Human ability. A continuation of 'the abilities of man'. London: Macmillan & Co.

Stanley, J., C. (1997). Varieties of intellectual talent. Journal of creative behavior, 31(2), 93-119.

Sternberg, R. J. (1990). Metaphors of Mind. Conceptions of the Nature of intelligence. Cambridge: Cambridge University Press.

Sternberg, R. J. (1996). Myths, countermyths, and truths about intelligence. Educational researcher, 25(2), 11-16.

Sternberg, R. J., Wagner, R. K., M., W. W., & Horvath Joseph, A. (1995). Testing common sense. American Psychologist, 50(11), 912-927.

Suzuki, L. A., & Valencia, R. R. (1997). Race-Ethnicity and measured intelligence. American Psychologist, 52(10), 1103-1114.

Thurstone, I. I. (1938). Primary mental abilities (BF431.T54 ed.). Chicago: The University of Chicago Press.

Thurstone, L. L., & Thurstone, T. G. (1941). Factorial studies of intelligence. Chicago: The University of Chicago Press.

Waldman, I., D. (1997). Unresolved questions and future directions in behavior-genetic studies of intelligence. In R. J. Sternberg & E. L. Grigorenko (Eds.), Intelligence, heredity and environment . New York: Cambridge university press.